

Rockwell Hanford Operations

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Abstract		Prepared by (Name and Dept. No.) B. A. Higley 65400 B. A. Higley See Page 2 for Approvals		Date 5/5/82																																																																																													
A technical basis has been developed for establishing a goal for system detection capability, action criteria, and monitoring frequencies for liquid observation wells. The goal for detection capability of the system is based on historical criteria and postulated technical capabilities of liquid observation well technology. A basis for establishing action criteria is presented. Frequency of monitoring is based on probable rates of intrusion or leakage, potential volumes involved, probability of an occurrence, and mitigating actions available.		<table border="1"> <thead> <tr> <th>* Distribution</th> <th>Name</th> <th>Mail Address</th> </tr> </thead> <tbody> <tr> <td colspan="3"><u>U.S. Department of Energy-RL</u></td> </tr> <tr> <td>*</td> <td>R. D. Izatt</td> <td>Fed. 700 Area</td> </tr> <tr> <td>*</td> <td>J. J. Schreiber</td> <td>Fed. 700 Area</td> </tr> <tr> <td>*</td> <td>A. R. Schwankoff</td> <td>Fed. 700 Area</td> </tr> <tr> <td colspan="3"><u>Rockwell Hanford Operations</u></td> </tr> <tr> <td></td> <td>D. C. Bartholomew</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>D. A. Berg</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>D. R. Carpenter</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>K. G. Carothers</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>J. L. Deichman</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>G. T. Dukelow</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>J. H. Garbrick</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>K. A. Gasper</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>R. J. Gurth</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>W. F. Heine</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>G. A. Huff</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>J. D. Keck</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>J. D. Keck</td> <td>271T/200 West</td> </tr> <tr> <td>*</td> <td>E. J. Kosiancic</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>J. D. Kaser</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>G. N. Langlois</td> <td>271-T/200 West</td> </tr> <tr> <td></td> <td>P. G. Lorenzini</td> <td>2750E/200 East</td> </tr> <tr> <td></td> <td>R. G. Oliver</td> <td>271-T/200 West</td> </tr> <tr> <td></td> <td>K. J. Pascoe</td> <td>2750E/200 East</td> </tr> <tr> <td></td> <td>R. C. Roal</td> <td>2750E/200 East</td> </tr> <tr> <td></td> <td>J. H. Roecker</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>C. M. Walker</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>D. G. Wilkins</td> <td>2750E/200 East</td> </tr> <tr> <td></td> <td>D. D. Wodrich</td> <td>2750E/200 East</td> </tr> <tr> <td>*</td> <td>H. C. Spanheimer</td> <td>2750E/200 East</td> </tr> </tbody> </table>			* Distribution	Name	Mail Address	<u>U.S. Department of Energy-RL</u>			*	R. D. Izatt	Fed. 700 Area	*	J. J. Schreiber	Fed. 700 Area	*	A. R. Schwankoff	Fed. 700 Area	<u>Rockwell Hanford Operations</u>				D. C. Bartholomew	2750E/200 East	*	D. A. Berg	2750E/200 East	*	D. R. Carpenter	2750E/200 East	*	K. G. Carothers	2750E/200 East	*	J. L. Deichman	2750E/200 East	*	G. T. Dukelow	2750E/200 East	*	J. H. Garbrick	2750E/200 East	*	K. A. Gasper	2750E/200 East	*	R. J. Gurth	2750E/200 East	*	W. F. Heine	2750E/200 East	*	G. A. Huff	2750E/200 East	*	J. D. Keck	2750E/200 East	*	J. D. Keck	271T/200 West	*	E. J. Kosiancic	2750E/200 East	*	J. D. Kaser	2750E/200 East	*	G. N. Langlois	271-T/200 West		P. G. Lorenzini	2750E/200 East		R. G. Oliver	271-T/200 West		K. J. Pascoe	2750E/200 East		R. C. Roal	2750E/200 East		J. H. Roecker	2750E/200 East	*	C. M. Walker	2750E/200 East	*	D. G. Wilkins	2750E/200 East		D. D. Wodrich	2750E/200 East	*	H. C. Spanheimer	2750E/200 East
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CRITERIA FOR LIQUID OBSERVATION WELL (LOW)
MONITORING OF THE HANFORD SINGLE-SHELL HIGH-LEVEL WASTE TANKS

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1.0 SUMMARY

Liquid Observation Well (LOW) monitoring is being developed to supplement current high-level waste tank surveillance programs. Efforts to stabilize the wastes by removal of supernates and by salt well pumping has, and will, reduce the ability to detect and verify leaks and intrusions. The capabilities and limitations of current detection methods are discussed in the Appendix.

Due to the complex chemical and thermal nature of the wastes, the tanks cannot be viewed as static systems. Processes which occur within the tank may mask or falsely indicate leaks or intrusions. The most significant of these processes are postulated to be Ostwald ripening, evaporation, refluxing of water, and structural changes of the salt cake.

As only limited experience is available in assessing the significance of these natural in-tank phenomena, action criteria cannot be established at this time. This study presents development goals for operation of the LOW system, and sets the schedule and logic for establishment of action criteria. Interim controls for use until the action criteria are available are also presented.

Based on current surveillance practice and the capabilities of LOW monitoring, the following development goal is proposed and discussed:

- To detect and verify changes in the interstitial liquid level in salt cake and sludge, equivalent to a liquid loss or gain of 1,500 gal, in waste with 45% porosity, i.e., a change of 1.2 in.

Tank status is an important factor in establishing applicability and frequency of LOW monitoring. The impact of tank status on the capabilities of LOW and current tank monitoring systems is presented and discussed. Tank status scenarios discussed include: (1) primary stabilized (to be jet pumped); (2) primary stabilized (jet pumping in progress); (3) interim stabilized; and (4) interim isolated. The complementary effect of LOW monitoring to current surveillance systems and the frequency of monitoring are also addressed.

2.0 INTRODUCTION

Current waste management plans call for the removal from single-shell storage tanks of all the drainable liquid to the degree that is practical. The intent is to stabilize the high-level waste and to minimize its potential for movement to areas beyond the boundaries of the tanks. As a supplement to this practice, the tanks are also being isolated by placing at least one barrier between the tank and any credible source of liquid. Unnecessary sources of water are also being removed from the farms.

Stabilization of the single-shell tank (SST) waste is currently limited by the technical feasibility of removing all of the drainable interstitial liquid by jet pumping. A maximum of 37,000 gal of interstitial liquid will remain in each tank after jet pumping is completed (Ref. 1).

Due to the removal of supernate and interstitial liquid, the capability for detecting leaks or intrusions with conductivity probes will be reduced. In tanks without supernate, conductivity probes are unable to detect leaks and will be able to detect only those intrusions which raise the liquid level above the salt cake level. Small leaks (less than 10,000 gal) may be entirely undetected by the current system of dry wells used to monitor the majority of the SSTs. In certain tanks, gaps in the dry well system would allow much more, up to the entire remaining drainable liquid inventory of the tank, to be released without detection. Liquid Observation Well monitoring would provide the capability of detecting many of these future leaks.

Because long-term integrity of SSTs cannot be assumed, detection of intrusions is of equal, if not greater importance than the detection of leaks. As an intrusion will negate whatever waste stabilization efforts that have been completed, it is imperative that intrusions be located and stopped as soon as possible. After jet pumping, intrusions of many thousands of gallons could go undetected by the current system of conductivity probes due to the large interstitial void volume existing in the salt cake. Conductivity probes would only be effective if the intrusion is large enough to produce a supernate layer above the salt cake or if the tank is not jet pumped. Liquid Observation Wells, however, will provide the capability to detect intrusions without the formation of a supernate layer.

Current efforts on the development of LOW technology have centered on proof of concept and mechanical details of the data collection and processing system. Based on the current state of mechanical development, this technology is expected to be transferred to the surveillance groups in early fiscal year 1983. To meet this schedule, several objectives must be accomplished in fiscal year 1982. In addition to the completion of mechanical development, the technology must be tested under a wide range of conditions to verify instrument performance. Waste parameters to be examined include variability (sludge or salts), moisture content, and temperature. The need for multiple wells in a single tank to detect leaks and intrusions or to monitor jet pumping will also be evaluated. This experience will be used to establish evaluation limits and action criteria.

The purpose of this study is to establish a development goal for the LOW system and to establish a schedule and plan by which action criteria will be established. Action criteria cannot be established at this time because the impact of natural in-tank phenomena on the interstitial liquid level is not known. It is expected that the magnitude of interstitial liquid level fluctuations may vary considerably between the tanks. Evaluation limits for use during the interim period are also needed.

3.0 CRITERIA

3.1 BASIS FOR SYSTEM DETECTION GOAL

The intent of the LOW program is to supplement existing monitoring systems and to replace monitoring systems as they become nonfunctional due to the removal of interstitial liquid. Of the systems currently available for detection of leaks and intrusions in the SSTs, the most extensive are the out-of-tank dry wells and the conductivity probes. Details of these systems are discussed in the Appendix.

Minimum action criteria for a conductivity probe is a supernate liquid level decrease of 0.5 in. and a 1.0 in. liquid level increase. Based on a 75-ft diameter tank, these changes correspond to a leak of 1,375 gal and an intrusion of 2,750 gal, respectively.

The conductivity probe systems used to monitor supernate liquid levels will detect changes much smaller than 0.5 in. Experience, however, has shown that natural fluctuations in liquid level of less than 0.5 in., that is, 1,375 gal of supernate, occur with sufficient frequency such that liquid level changes of less than 0.5 in., i.e., the current minimum action criterion, are not considered to be significant.

Based on an assumed waste porosity of 45%, an intrusion or leak of 1,375 gal of liquid would cause an interstitial liquid level change of 1.1 in. in a 75-ft diameter tank. The gamma and neutron probe system currently being developed for LOW monitoring collects data at 0.1 ft (1.2 in.) intervals and currently can be made to collect data at 0.05 ft (0.6 in.) intervals (Ref. 2). An interstitial liquid level change of 0.1 ft in a waste of 45% porosity would be equivalent to a liquid volume change of 1,500 gal.

When a tank has been stabilized, the corrective actions available to manage leaks and small intrusions will be severely limited. The difference between 1,500 gal and 1,375 gal therefore can be taken as being minor (9%) and changes of interstitial liquid level of less than 1.2 in. in waste of 45% porosity are probably not significant.

Based on the historical fluctuations of supernate liquid levels, the expected capabilities of the LOW equipment, and the feasibility of taking corrective action, it is believed that a realistic development goal for operation of the LOW system and lower limit for criteria is as follows:

- To detect and verify changes in the interstitial liquid level in salt cake and sludge, equivalent to a liquid loss or gain of 1,500 gal, in waste with 45% porosity, i.e., a change of 1.2 in.

3.2 IMPLEMENTATION OF CRITERIA

Due to the limited knowledge of interstitial liquid behavior any attempt to immediately establish action criteria would be premature.

Several in-tank processes not related to leaks or intrusions which may contribute to fluctuation or change of the interstitial liquid level are discussed in Section 4.3.

Response of the interstitial liquid level to a change in liquid inventory, due to jet pumping, leaks, or intrusions, is expected to be slow. At least 1 to 2 weeks and, possibly several months, may be required for the interstitial liquid level to stabilize after jet pumping. This may cause a considerable delay in establishing a baseline interstitial liquid level.

Consideration of the porosity of the waste may also be required so that criteria can be appropriately applied to each of the tanks. When a waste porosity of 45% is assumed, an intrusion or leak of 1,500 gal of liquid would cause an interstitial liquid level change of 1.2 in. in a tank. Porosity of the waste in many of the tanks, however, may be appreciably less due to sludge content, subsidence, and crystal growth. Wastes with porosities significantly greater than 45% would not be expected (Ref. 3).

Observations made during and shortly after saltwell pumping would provide a basis for estimating waste porosity and adjusting the criteria.

3.2.1 Criteria During Development

No criteria will apply to the interpretation of LOW scans during the development program in FY 1982. Liquid level changes however, which are greater than 2.4 in. will be subject to trend analysis and evaluation.

3.2.2 Evaluation Limit

When the LOW system is degraded or operated in a degraded mode, evaluation limits will be established for use until final action criteria are available. An interstitial liquid level change of 1.2 in. will be used as the evaluation limit unless capability of the LOW system is not verified by field tests or if experience obtained during the field tests indicate that larger fluctuations of the interstitial liquid level can occur in a static tank. If during the field tests, deviations from the baseline are observed and confirmed to be greater than 1.2 in., the evaluation limit will be set at the largest deviation observed. For purposes of establishing a baseline, static behavior of the interstitial liquid level for at least 6 observations, at a minimum interval of 2 weeks, will be needed. Tanks for which a baseline cannot be established within 3 months of completing jet pumping will be evaluated.

3.2.3 Action Criteria

Final action criteria will be established on an individual basis for each tank. Once a tank is static, the first 26 observations taken at a

minimum interval of 2 weeks, including those used to establish the baseline will be used to set action criteria. If interstitial liquid level changes of greater than 1.2 in. are observed for a particular tank, a value equal to the largest fluctuation observed and confirmed, plus the standard deviation of the observations, will be used as the action criteria. If all deviations observed are less than 1.2 in., a minimum action criteria of 1.2 in. will be established. However, if evidence exists that the porosity of the waste is less than 45%, the minimum criteria for that tank will be the liquid level change equivalent to a gain or loss of 1,500 gal of interstitial liquid.

Action criteria will be established as soon as possible. For tanks with existing LOWs, data collected during the development program would be reviewed and applied to establishment of the action criteria.

4.0 DISCUSSION

4.1 LIQUID OBSERVATION WELL MONITORING PROBES

Three different types of probes are being developed for LOW monitoring. The acoustic probe uses ultrasonic detectors for transmitting and receiving the signal. This device is most useful for accurately determining distinct liquid levels. The neutron probe uses a fast neutron source and measures moisture content by detection of the reflected and moderated neutrons with a slow neutron detector. The gamma detector uses a Geiger-Müller detector enclosed in a highly collimating lead shield. The gamma measurement technique approach is based on the fact that the major gamma emitters are in the liquid phase rather than in the salt crystal (Ref. 2).

4.2 CAPABILITIES OF THE LIQUID OBSERVATION WELL

Data plots produced by the LOW probes not only provide information on liquid level and moisture distribution but may also provide information on processes occurring within the waste. These scans are expected to be useful in tracking and identifying such phenomena as subsidence and refluxing.

4.2.1 Acoustic Probe

The most useful function of the acoustic probe is the accurate determination of interstitial liquid levels. Resolution and repeatability of the prototype acoustic probe system are both less than 0.25 in. Amplitude variation exhibited by acoustic probe scans follow moisture variation present in the waste.

4.2.2 Neutron Probe

The neutron probe can identify interstitial liquid levels, though not as precisely as the acoustic probe. During a scan it is possible to collect data in intervals as small as 0.05 ft (0.6 in.), but the absolute position of the probe is only known to within 0.1 ft (1.2 in.). This uncertainty in the position of the probe is due to the fact that the probe lowering and lifting mechanism is mounted on a truck and therefore is not firmly fixed relative to the LOW. With the equipment being developed to stabilize the probe it will be possible to collect data at intervals of 0.05 ft (0.6 in.). The absolute position of the probe will be known to within one data interval. Determination of the interstitial liquid level by visual analysis of the neutron probe scan is limited to within ± 0.1 ft (± 1.2 in.) due to scatter in the data. Computer analysis of the data will be investigated to see if resolution can be improved. Reduction of the data interval and slowing of the scan will also be considered as ways to improve resolution. In addition to measuring the salt cake surface, the moisture levels in drained salt cake and in salt cake flooded with liquid can also be determined. Differentiation between salt cake and sludge may also be possible.

4.2.3 Gamma Probe

Resolution and accuracy of the gamma probe are nearly identical to that of the neutron probe. The operating principle of the gamma probe is based on the gamma emitting radionuclides being concentrated in the liquid phase of the wastes. In addition to indicating salt cake and liquid levels, the probe through gamma activity changes, can track intrusions by the resulting dilution; and detect crystal growth by the distribution of gamma activity. Processes within the tank which result in moisture or gamma activity redistribution such as draining and leaching of the upper layers and refluxing from the bottom of the tank may also be tracked with this probe. Interpretation of these effects, however, is mostly subjective at this time.

4.2.4 Liquid Observation Well Installation

Data plots of the probes actually start some distance above the tank bottom because of tank floor slope, tank floor to LOW clearance, length of well point, etc. Assuming LOWs can be installed to within 1 in. of the tank floor, the minimum distance of the probe detector from the bottom of the tank would be about 5 in. plus an allowance for floor slope. This assumption may not be valid for tanks which contain hardened wastes such as dried sludge. The presence of these wastes may make installation of a LOW to within one inch of the tank bottom difficult or impossible.

Some of the liquor which will remain in the tanks will be capillary held and therefore, nondrainable. Capillary height of the waste is a measure of height to which interstitial liquid will be held by capillary forces. Capillary height of a specific waste is dependent on properties of the liquor and pore diameter of the waste. For wastes where the height

of the capillary held liquor is greater than or equal to the height of the solids, all of the interstitial liquor remaining in the tank will be non-drainable. This condition may hold for much of the sludge wastes. For these wastes, intrusions to the tank would immediately form a supernate layer which could be detected by conductivity probes. The decision to place LOWs in these tanks should be determined on a tank by tank basis.

4.3 PHENOMENA INTERFERRING WITH LOW DATA INTERPRETATION

Removal of the interstitial liquid may initiate or alter several in-tank processes, many of which are not fully understood. In addition, the local environment of the LOW may not be representative of the contents of the entire tank.

4.3.1 Temperature

Removal of interstitial liquid from the salt cake will simultaneously reduce the radioactivity and the thermal conductivity of the waste. The net result may be that the temperature of salt cake will rise, which according to laboratory tests, results in a release of liquor due to solubility of the crystals and reduced viscosity of the liquor.

4.3.2 Ostwald Ripening

When in contact with a mother liquor, the thermodynamic tendencies are for small crystals to dissolve and larger crystals to grow. The overall effect is a release of capillary held liquid as the surface to volume ratio of the crystal mass decreases. The existence of regions of massive crystals in the tanks have been postulated based on gamma and neutron scans taken during the prototype development program. The extent and rate of Ostwald ripening is unknown as the dependence of the thermodynamic equilibrium on temperature, liquor composition, etc., is not known.

4.3.3 Evaporation

Depending on the heat generation rates within the waste, water will evaporate at various rates and can leave the tank through breathing filters or tank exhausters, depending on how the tanks are equipped. The resulting moisture loss might be falsely interpreted as a leak if this effect is not properly accounted for.

4.3.4 Refluxing

Water vapor, generated by hot spots within the waste, which does not escape from the tank will condense on the dome and in cooler portions of the waste bed. This water, trickling down through the salt cake beds, will leach the salts. A shift of gamma activity and a change in porosity of the bed could result. Proper interpretation of these changes is required to prevent confusion with leaks and intrusions.

4.3.5 Structural Changes

Removal of the interstitial liquid could potentially result in subsidence and compaction of the wastes. The resultant reduction of pore volume in the lower regions of the tank would displace liquid, thereby, increasing the liquid level which may be mistaken for an intrusion. Any observed subsidence would be taken into consideration when evaluating liquid level changes.

4.3.6 Nonuniformity

The capability of the probes to detect beyond the immediate vicinity of the LOW is limited. The ultrasonic system of determining liquid level in a waste tank as currently being tested sees no further than the LOW waste interface. The information zone for the neutron probe is estimated at 3 ft, while that of the gamma probe is estimated at 6 in. (Ref. 4).

Physical, chemical, and nuclear properties can vary widely within a tank. Localized processes within a tank may be occurring. As an example, in-tank photography indicates that in tanks of dried sludge, wet spots directly under the riser can exist due to condensation in the riser. If only LOW data were available, a higher than actual moisture content probably would be concluded.

Uniformity of an interstitial liquid level within a tank and how it responds to intrusions or leaks is also an uncertainty. As a test, multiple wells are to be installed in a single tank so that differences in interstitial liquid level due to location can be detected.

4.4 IMPLICATIONS OF TANK STATUS

~~As part of a continuing effort to safely manage the single-shell storage tanks, jet pumping will be used to remove all the drainable liquor that can be recovered practically. Jet pumping will take several years to complete. The individual tanks will be at various stages of stabilization and isolation during and after this time (Ref. 5). These changes in status will impact the need for surveillance and the capabilities of monitoring.~~

4.4.1 Primary Stabilized Tank - To Be Jet Pumped

The principal concern in this situation is that leaks not go undetected. In this case a definite liquid level should be observable by any of the LOW probes. In this situation, detection of a leak may advance the schedule for jet pumping. If only a small amount of water intrudes it is likely that no action would be taken immediately. As discussed by Isaacson (Ref. 6), with the exception of 241-T-106, leak rates have been low and the postulated worst case leak would be 0.03 gal/min (43 gal/day). Loss of 1,500 gal of interstitial liquid at this rate would take 35 days and

would lower the interstitial liquid level 1.2 in. (assuming a porosity of 45%). Monitoring on a 5 week interval should be adequate to detect this worst case leak on a timely basis. Intrusions to the tank would be monitored daily by conductivity probes at the waste surface. The conductivity probes could be FICs, manual tapes, or fixed probes.

4.4.2 Primary Stabilized Tank - Jet Pumping in Progress

Due to the time required for an interstitial liquid level to form or stabilize, LOW monitoring will be virtually useless for detecting leaks and intrusions which are on the order of the pumping rate. Installation of a LOW prior to pumping would allow porosity of the waste to be determined from the moisture profile produced by the neutron probe. During pumping LOW monitoring of the movement and distribution of liquid may be useful in measuring the progress and verifying the completion of jet pumping.

4.4.3 Interim Stabilized Tank

This classification includes both tanks where jet pumping has been completed and tanks which do not contain sufficient drainable liquid to justify jet pumping. These tanks may contain up to 37,000 gal of interstitial liquid of which 22,000 gal may be drainable. The amount of liquid which remains undrainable depends upon the capillary holdup of the waste. For salt cake the volume of capillary held liquid per tank is calculated to be 15,000 gal; sludges would have a higher hold up. Only those tanks containing more than 82,500 gal of waste are recommended for jet pumping (Ref. 1). Tanks containing less than this amount will contain less than 37,000 gal of interstitial liquid. As the remaining liquid cannot be removed by currently available technology, interest in detection of a leak is limited to verifying whether or not a leak has occurred so that the extent of the leak can be determined. Detection of a leak from an interim stabilized tank may become more of a concern if an advanced stabilization process is developed and implemented. Liquid observation wells, however, would be useful in tracking transient processes within the tanks such as Ostwald ripening and evaporation. The primary concern in management of an interim stabilized tank is that intrusions do not occur and that if an intrusion does occur, it is detected and stopped as soon as possible. Until all known pathways for intrusion are blocked and the tank is isolated, the intrusion of an interim stabilized tank must be considered to have a real probability of occurrence. Frequent LOW monitoring, therefore, may be required.

Several classes of intrusions are possible: (1) liquid from saturated soil which enters by seepage; (2) intrusions of water from rain and snowmelt; (3) leaks from equipment which drain directly back to a tank; and (4) liquid which enters due to an error in a transfer routing or other tank farm activity.

It is postulated that liquid from saturated soil may accumulate in the tank at a rate very similar to that of a leak. Assuming that a worst case intrusion by seepage is equivalent in rate to that of a worst case leak (0.03 gal/min) monitoring of the LOW once every five weeks should be sufficient to detect intrusions of this type.

Intrusions due to rain and snowmelt can happen very quickly but are of limited volume. The current continuing effort to isolate the tanks should minimize this problem.

Valves, connections, pumps, etc. are all potential sources of liquid which may find its way back into a tank via pit drains. Either process liquor or raw water may be involved. Current plans to install water meters at all tank farms and to monitor them via the Computer Automated Surveillance System (CASS) is expected to provide adequate primary surveillance for detection of raw water intrusions. In this instance, LOW monitoring would be considered as secondary surveillance. Leaks of process liquor are expected to be small and infrequent due to the nonactive status of single-shell tanks. Liquid observation well monitoring would be used to periodically check for the occurrence of these intrusions.

Intrusions due to tank farm transfer errors can occur very quickly and can involve a few hundred to several thousand gallons of liquid. Although the possibility of this occurrence is real, it's probability has been reduced substantially by the current inactive status of the single shell tanks. Primary surveillance for these intrusions is provided by material balance procedures and by conductivity probes. These techniques provide only partial coverage as material balance procedures are not feasible for small volume transfers and conductivity probes are only functional when the intrusion is large enough to form a supernate layer. Periodic LOW monitoring will provide the means to ascertain the existence and size of intrusions not detected by conductivity probes and material balance procedures.

4.4.4 Interim Isolated Tank

Concerns for isolated tanks are similar to those for interim stabilized tanks. As with the interim stabilized tanks the greatest concern deals with the potential for an intrusion. The concern over intrusions is increased over that for an interim stabilized tank as many of the process lines required to manage an intrusion may no longer be readily accessible. The risk, however, of experiencing an intrusion has been considerably reduced by the placing of "at least one credible barrier between the tank and the source of liquid." The need for LOW monitoring is therefore reduced. As surrounding tanks are isolated and moisture distributions stabilize, monitoring will be reduced from once every 5 weeks to a maximum interval of a year. Monitoring on an annual schedule is consistent with the maximum interval proposed for dry well monitoring of interim isolated tanks (Ref. 7). This reduction is justifiable on the basis that the probability of an intrusion after isolation is remote and the means to reduce the occurrence and mitigate the consequences of leaks

are not available. The reduction in frequency would be carried out as a stepwise process and would require justification by experience. Reduced monitoring schedules would be maintained until a leak, an intrusion, or an unexplained anomaly in the data occurred. Monitoring would then revert to a more frequent schedule until the problem was identified and corrected.

5.0 RECOMMENDATIONS

Based on the preceeding discussion it is recommended that development of the LOW monitoring system be directed toward meeting the following goal:

- To detect and verify changes in the interstitial liquid level in salt cake and sludge, equivalent to a liquid loss or gain of 1,500 gal, in waste with 45% porosity, i.e., a change of 1.2 in.

During the development period (FY 1982) it is recommended that as a control, deviations of the interstitial liquid level equal to or greater than 2.4 in. be evaluated.

Action criteria will be established on a tank by tank basis. Until LOWs are installed and adequate experience is available to establish action criteria, an evaluation limit, based on development experience, will be used. The basis recommended for establishment of the evaluation limit and action criteria is summarized in Table 1.

Recommended frequencies of LOW monitoring based on tank status are presented in Table 2.

TABLE 1. Criteria for LOW Monitoring.

Evaluation Limit	Action Criteria
<p>The evaluation limit will be the greater of:</p> <p>a) 1.2 in.</p> <p>b) The maximum interstitial liquid level fluctuation observed and confirmed during the development period.</p>	<p>The action criterion established for a tank will be the greater of:</p> <p>a) 1.2 in.</p> <p>b) The interstitial liquid level change equivalent to a loss or gain of 1,500 gal of liquid based on evidence of waste porosity of less than 45%.</p> <p>c) The interstitial liquid level change equal to the largest fluctuation observed and confirmed plus one standard deviation of the interstitial liquid level observations for that tank.</p>

TABLE 2. Recommended LOW Monitoring Frequencies for Surveillance of High-Level Waste Tanks.

Tank Status	Primary Concern	Monitoring Frequency
Primary Stabilized, to be jet pumped	Leak	5 Weeks
Primary Stabilized, Jet Pumping in Progress	Leak, Process Control	As needed to monitor pumping ²
Interim Stabilized	Intrusion ¹	5 Weeks
Interim Isolated	Intrusion ¹	Annual ³

¹Leaks are of secondary concern as corrective action may no longer be technically and economically feasible, due to the small liquid inventory present.

²Leak and intrusion detection not possible with LOWs during jet pumping.

³More frequent monitoring may be required until the entire farm is isolated and isolation is verified.

6.0 REFERENCES

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APPENDIX A

CURRENT MONITORING OF SINGLE-SHELL TANKS

External Dry Well Monitoring

Various probes are used in external dry wells to "log" moisture variation and radiation levels. A total of 756 external dry wells associated with the SSTs are being monitored at this time. Sensitivity of the external dry well system to leaks is a function of the number and location of the dry wells around a tank. To assure that the maximum volume of a leak undetected by external dry well monitoring is limited to 10,000 gal would require installing 328 new dry wells. A limit of 20,000 gal would require 153 new wells be installed (Ref. 8). Many of the tanks contain liquor volumes well under their individual external dry well detection limit, thereby, making the detection of leaks from these tanks improbable.

Conductivity Probes

Conductivity probes, either automatic or manual, are utilized to measure liquid levels within the tanks. Many of the probes are non-functional as leak detectors due to the removal of supernates. As salt well pumping progresses, additional conductivity probes will become non-functional as leak detectors. However, conductivity probes will still remain functional as detectors for those intrusions large enough to produce a supernate layer. For measuring supernate levels, conductivity probes are considered to be accurate to 0.25 in. Any change in the liquid level greater than an established value requires a determination of the cause. Typical values established as action criteria for liquid level decreases are 0.5 and 1.0 in. depending on whether the monitoring system is automatic or manual. For liquid level increases, 1.0, 2.0, and 3.0 in. are the established values of action criteria. Action criteria for the conductivity probes are based on experience. The criteria allow for natural fluctuation of the supernate liquid level and variation of the waste surface. When the action criteria is exceeded, a determination is made as to whether a leak or intrusion has occurred. If a leak is confirmed by another monitoring system or no other reasonable explanation exists, the drainable contents of the leaking tank are transferred to another tank. If an intrusion has occurred the source is located and the influx is stopped. The minimum action criteria of 0.5 in. decrease in supernate level for a leak is equivalent to a loss of 1,375 gal for a 75-ft diameter tank. The minimum action criteria for an intrusion of 1.0 in. is equivalent to a gain of 2,750 gal.

Laterals

Tanks in 241-A Farm and nine of the tanks in 241-SX Farm have a lateral monitoring capability. Laterals are essentially dry wells which run horizontally under the tanks. The maximum undetectable leak from tanks so equipped is 5,000 gal (Ref. 8).

Leak Detection Pits

The most recently constructed SSTs located in 241-AX Farm were built over a collection grid which drains to a pit. Sensors placed in the pit monitor liquid and radiation levels. This system is considered to have a leak detection capacity of about 100 gal for leaks from the bottom of the tank (Ref. 8).

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